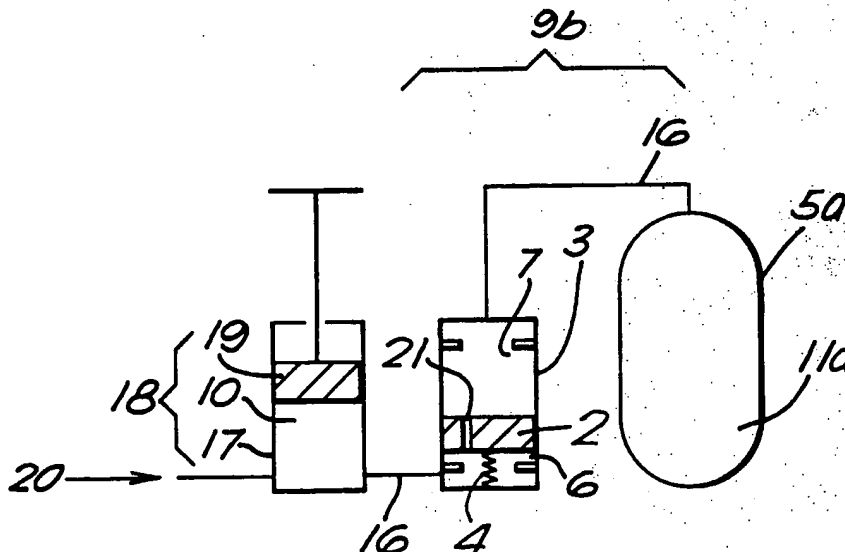




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(54) Title: A PROGRESSIVE AIR SPRING



(57) Abstract

A progressive gas spring device, designed e.g. for drivers' seats in trucks. This device includes a gas spring (18, 18c), a gas-tight vessel (5, 5c) as well as between the gas spring and the vessel, a pneumatic connection (9a, 9b, 9c), which comprises elements (14, 3, 3c), designed to maintain said pneumatic connection, when the strokes of the spring are moderate, and to disconnect said pneumatic connection, when the strokes of the spring are larger.

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A PROGRESSIVE AIR SPRING

THE TECHNICAL FIELD

The present invention relates to a progressive gas spring device, designed to support e.g. the driver's seat in a truck.

THE BACKGROUND OF THE INVENTION AND THE STATE OF THE ART

Investigations performed of vibrations in trucks and similar vehicles have shown, that these vehicles generally have a vibration maximum in the vertical direction with a frequency of about 2 Hz. The maximum acceleration of these vibrations can be as high as 1 g for a modern truck. Thus, a seat and the driver in it ought to have a resonance frequency of less than 0.5 Hz.

If the weight of the driver is about 80 kg and the movable mass of the seat is about 20 kg, the spring constant must be less than 0.8 N/mm, if the resonance frequency of the driver and his seat will fall below 0.5 Hz.

Thus, the spring ought to have a low spring constant, when the strokes upwards or downwards are moderate, e.g. 15-20 mm downwards and 10-15 mm upwards. Subsequently, the spring ought to be progressive in order to avoid too large movements in the vertical direction.

Known mechanical or pneumatic spring systems require a substantial space in order to make the spring device progressive and simultaneously give it the above-mentioned low spring constant.

A DESCRIPTION OF THE INVENTION

The object of the present invention is to suggest a device, by means of which the drawbacks of known devices can be eliminated. Primarily, the object is to suggest a spring device, which provides a progressive spring suspension with a very

low spring constant, when the strokes of the spring are moderate, the space requirement of the spring at the same time being small.

5 This object has been attained with a device, which comprises a gas spring, a gas-tight vessel with a volume, which is more than twice as large as the maximum gas volume of the spring, a pneumatic connection between the gas spring and the vessel as well as means designed to maintain said pneu-
10 matic connection, when the strokes of the spring are moderate, and to disconnect the pneumatic connection, when the strokes of the spring are larger.

The gas-tight vessel can be placed somewhere adjacent e.g.
15 the driver's seat and thus will not intrude on the scarce space, which is available for the mounting of the spring device. Also, the gas-tight space can be designed and adjusted with regard for the available spaces.

20 Additional characterizing features and advantages of the present invention will be set forth in the following description as well as the following patent claims.

A BRIEF DESCRIPTION OF THE DRAWINGS

25 In the following description reference will be made to the accompanying drawings, in which:

Fig. 1 shows the basic construction of a progressive gas spring according to the invention;

Fig. 2 shows an embodiment, having a piston cylinder as a
30 pneumatic connection between the gas spring and a gas vessel;

Fig. 3 shows an additional embodiment of the device according to the invention; and

Fig. 4 shows schematically how the device according to Fig. 3
35 can be used to support a driver's seat.

A DESCRIPTION OF A PREFERRED EMBODIMENT

In Fig. 1 a gas spring 18 comprises a cylinder 17, a piston 19 as well as a resilient gas volume 10. Gas spring 18 is connected to a gas vessel 5a by means of a pneumatic connection 9a, which includes a gas conduit 16, a valve 14 and a check valve 15.

The piston rod, which is attached to piston 19, is provided with a lifter 12, which via a roller 13 actuates valve 14 in order to close it, when the deviation of the piston upwards or downwards from a certain zero position or initial position is exceeded. Check valve 15 mainly has a balancing function, particularly in connection with the closing and the opening of valve 14.

When the deviations from the initial position are moderate, the resilient gas volume includes partly space 10 and partly contents 11a of gas-tight vessel 5a. When a deviation from the initial position is larger, the connection between gas spring 18 and vessel 11a is closed and consequently the resilient gas volume is reduced considerably.

Thus, the spring device according to Fig. 1 will have a soft resilience, when the deviations from the initial position are moderate. When the deviations from the initial position are larger, the resilience will be tougher in connection with the reduction of the resilient gas volume.

Thus, the spring device will have a comparatively low spring constant, when the gas connection between gas spring 18 and vessel 5a is open. The value of the spring constant will be substantially higher, when valve 14 is closed, because piston 19 reaches a position with a larger deviation from the initial position.

Arrow 20 indicates a device, which feeds gas to gas spring 18. Air feed 20 can be done manually or automatically. In case

the permanent load varies, e.g. if the loads are different drivers on a seat, who have different weights, it is possible to adjust the zero position or initial position by means of a pressure increase or pressure decrease.

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In the spring device according to Fig. 2 the pneumatic connection between gas spring 18 and vessel 5a comprises a conduit 16 and a cylinder valve 3. Cylinder valve 3 includes a piston 2, which in its upper position seals against a seat 7 and in its lower position seals against a seat 6. A spring 4 is designed to bring back piston 2 to its initial position between seats 6 and 7. The return to the initial position is possible, because a certain leakage exists between the cylindric part of cylinder valve 3 and piston 2. Also, the piston can be provided with openings or a hole 21, designed to increase the leakage, shown in Fig. 2.

Also in the device according to Fig. 2 the initial position of the piston can be adjusted in order to adapt it to different loads, by means of device 20 for the gas feed. This device is identical with the device shown in the spring device according to Fig. 1.

If piston 19 in the device according to Fig. 2 is loaded, a compression in space 10 being obtained, piston 2 will be raised and at the same time the gas in vessel 5a will be compressed, provided the loads are moderate and the deviations from the initial positions of pistons 19,2 are moderate. When the load is larger and consequently the deviation from the initial position of piston 19 is larger, piston 2 will also obtain a larger deviation from its initial position. Piston 2 will then reach either seat 6 or seat 7. As soon as piston 2 has reached one of these seats, a continued movement in the same direction of piston 2 will be stopped. Thus, when the stroke of piston 19 is larger, the movement of piston 2 will be limited by seats 6 and 7. Thus, the resilient gas volume will be limited to gas volume 10. Con-

sequently, the device according to Fig. 2 will provide a soft spring suspension with a comparatively small spring constant, when the strokes are moderate, because the resilient gas volume includes partly gas volume 10 of the gas spring and partly gas volume 11a of vessel 5a.

If the strokes of piston 19 are larger, which strokes are obtained e.g. in connection with larger loads, piston 2 will reach an end position, e.g. seat 7, and subsequently gas volume 11a of vessel 5a will no longer be directly influenced by the movement of piston 19. Thus, the resilient gas volume will be reduced and a tougher spring suspension will be obtained, when the strokes of piston 19 are larger. Basically, the devices according to Fig. 1 and Fig. 2 have a similar mode of operation with a soft spring suspension with a small spring constant, when the deviation of piston 19 from its initial position is moderate, and with a tough spring suspension, when the deviation exceeds certain limit values upwards or downwards.

In the device according to Fig. 1 said limit values are defined by means of the design of lifter 12. In the device according to Fig. 2 spring 4 can be adjustable in a way known per se. In this way the zero position of piston 19 can be adjusted, the ratio between a maximum stroke upwards and a maximum stroke downwards of piston 19 within the interval of a soft spring suspension being the desired one.

Fig. 3 shows a preferred embodiment of a spring device, which basically is constructed like the device according to Fig. 2. The spring device includes a gas spring 18c, a tight gas vessel 5b as well as a pneumatic connection 9c between gas spring 18c and gas vessel 5c. Air spring 18c comprises a bellows 1, which contains a gas volume 10c, and a base plate 8. Pneumatic connection 9c between air spring 18c and vessel 5b comprises a cylinder 3b, a piston 2b as well as a spring 4b.

When gas spring 18c is compressed, volume 10c, which is contained in bellows 1 will decrease, which moves piston 2b upwards towards seat 7b. Provided the piston has not reached seat 7b, the resilient gas volume comprises gas volume 10c and gas volume 11c, which is contained in vessel 5b. Thus, the gas volume is fairly large and the spring suspension is soft. When piston 2b has reached seat 7b, it is not able to continue to move upwards and when gas spring 18c is compressed further, the resilient gas volume will comprise only volume 10c, which results in a tougher spring suspension.

Thus, a spring suspension having a higher spring constant and consequently progressivity will be obtained, when the movement of piston 2b upwards or downwards is limited by means of seats 7b and 6b respectively, and the relative volume variation increases, since only the smaller gas volume 10 c, which is contained in bellows 1, is involved.

An additionally increased progressivity is obtained, if the compression is continued, when the bellows is folded against the upper surface of base 8 and against the lower surface of vessel 5b, the pressure surface being increased.

The initial position or zero position of piston 2 preferably is located slightly below the center point between seats 7b and 6b. Piston 2 is retained in this position and is returned to the zero position by providing a suitable leakage between piston 2 and cylinder 3b. With varying premanent loads the elevation of the spring device, i.e. the elevation of the upper surface of container 5b as compared to base plate 8, can be adjusted by changing the permanent pressure of the system.

The embodiment shown in Fig. 3 allows a condensed construction of the spring device according to the present invention. According to Fig. 4 the larger gas volume in vessel 5c can e.g. be placed in a driver's seat, if the spring

device is used for such a seat. However, the larger volume can also be placed in any suitable space adjacent the driver's seat.

- 5 Other modifications of the described embodiment than the ones shown above are also feasible without deviating from the basic principles of the present invention and without letting the modified device end up outside the limits of the patent claims set forth infra.

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CLAIMS

1. A progressive gas spring device, designed to support
e.g. the driver's seat in a truck, c h a r a c -
t e r i z e d by a gas spring (18, 18c), a gas tight
5 vessel (5a, 5b) with a volume, which is at least twice as
large as the maximum gas volume of the spring, and between
the gas spring and the vessel a pneumatic connection (9a,
9b, 9c), which comprises a cylinder (3, 3b), one end of
which is connected to the gas spring (18, 18c) and the
10 other end of which is connected to the vessel (5b), and a
cylinder piston, provided to seal against seats (6, 7, 6b,
7b) in its end positions, disconnecting the pneumatic
connection between the gas spring and the vessel (5a, 5b),
and wherein the cylinder piston allows leakage and is
15 provided to be returned to the zero position by means of a
spring (4, 4b).

2. A gas spring device according to claim 1, c h a r a c -
t e r i z e d in that the pneumatic connection between
20 the gas spring and the vessel comprises a gas conduit (16)
between the gas spring and the valve element as well as a
gas conduit (16) between the valve element and the vessel
(5a).

25 3. A gas spring device according to claim 1, c h a r a c -
t e r i z e d in that said valve element (3, 14) is
attached to the gas spring and in that said pneumatic
connection includes a gas conduit (16) between the valve
element and the vessel (5a).

30 4. A gas spring device according to claim 1, c h a r a c -
t e r i z e d in that said valve element (3, 14) is
attached to the vessel and in that said pneumatic
connection includes a gas conduit (16) between the valve
35 element and the gas spring.

5. A gas spring device according to claim 1, characterized in that said valve element (3b) is attached to the gas spring as well as the vessel (5b).

- 5 6. A gas spring device according to any of the preceding
claims, characterized in that said spring (4,
4b) is designed to provide the piston (2, 2b) with a zero
position, which is close to one of the seats (6, 6b), the
distance between the zero position and the other seat (7,
10 7b) exceeding the distance between the zero position and
the first seat close to the gas spring by between 10 and
30 %.

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FIG. 1

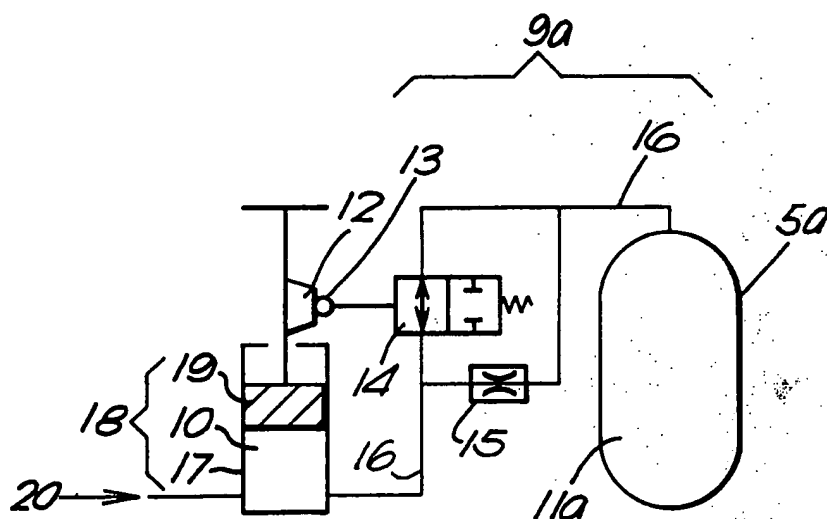
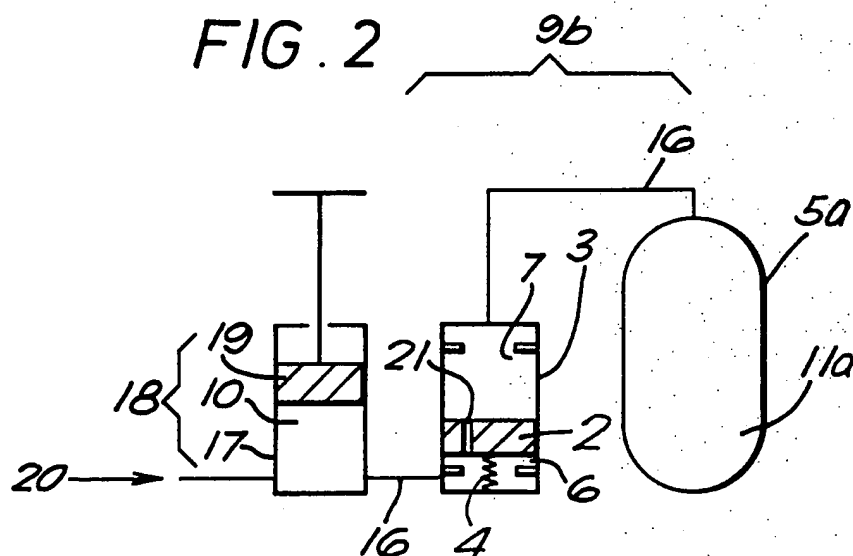


FIG. 2



4/2

FIG. 3

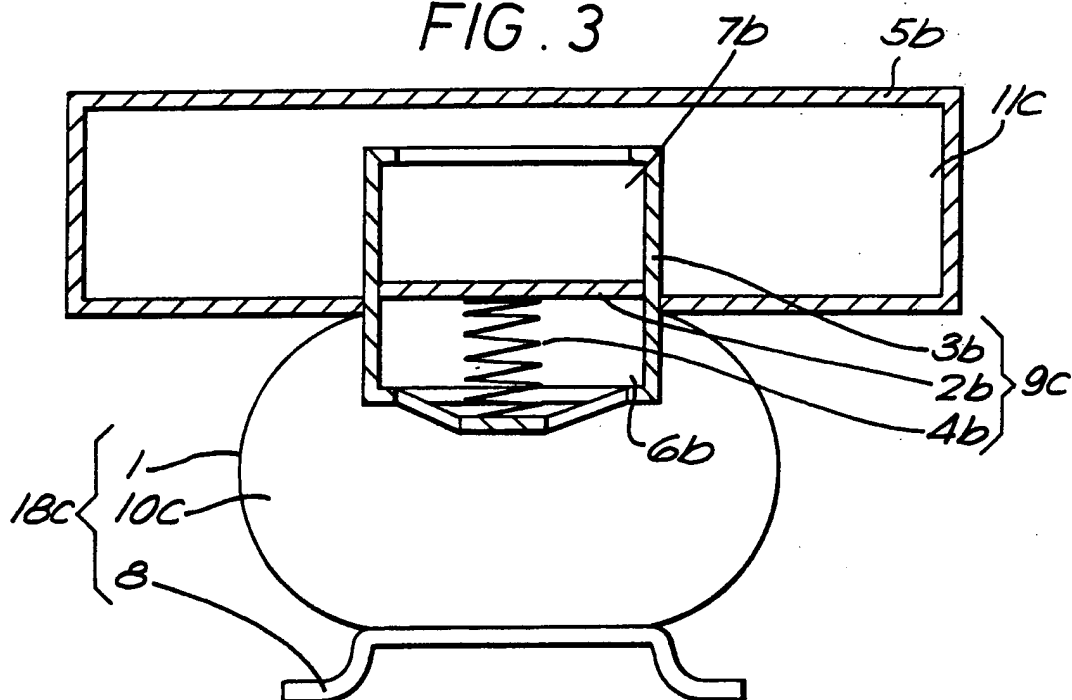
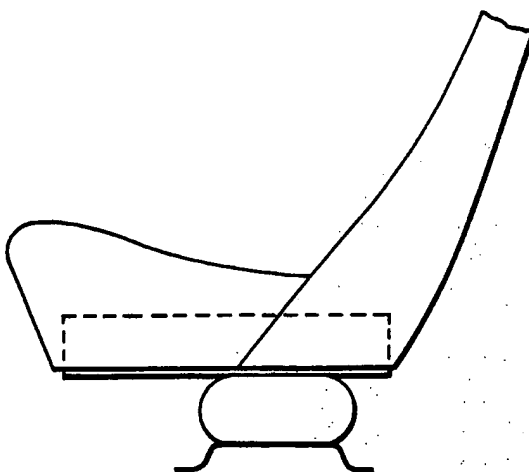


FIG. 4



INTERNATIONAL SEARCH REPORT

International Application No PCT/SE 90/00628

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ⁵ According to International Patent Classification (IPC) or to both National Classification and IPC IPC5: F 16 F 9/02														
II. FIELDS SEARCHED <div style="text-align: center; border-top: 1px solid black; border-bottom: 1px solid black; margin: 2px 0;">Minimum Documentation Searched⁷</div> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%; border-bottom: 1px solid black; padding: 2px;">Classification System</td> <td style="border-bottom: 1px solid black; padding: 2px;">Classification Symbols</td> </tr> <tr> <td style="padding: 5px;">IPC5</td> <td style="padding: 5px;">F 16 F; B 60 G</td> </tr> </table> <div style="text-align: center; border-top: 1px solid black; border-bottom: 1px solid black; margin: 2px 0;">Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched⁸</div> <p style="padding: 5px;">SE,DK,FI,NO classes as above</p>			Classification System	Classification Symbols	IPC5	F 16 F; B 60 G								
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III. DOCUMENTS CONSIDERED TO BE RELEVANT⁹ <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%; padding: 2px;">Category</th> <th style="width: 60%; padding: 2px;">Citation of Document,¹¹ with indication, where appropriate, of the relevant passages¹²</th> <th style="width: 30%; padding: 2px;">Relevant to Claim No.¹³</th> </tr> </thead> <tbody> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="padding: 5px;">DE, A, 2200356 (ROBERT BOSCH GMBH) 12 July 1973, see the whole document --</td> <td rowspan="4" style="width: 30%;"></td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="padding: 5px;">DE, B, 1021732 (MASCHINENFABRIK AUGSBURG-NURNBERG A.G.) 27 December 1957, see the whole document --</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="padding: 5px;">WO, A1, 8912766 (THE UNIVERSITY OF LANCASTER) 28 December 1989, see the whole document --</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="padding: 5px;">Derwent's abstract, No. 89-240 255/33, SU 1 458 629, publ. week 8933 (COACH BUILDING RES) --</td> </tr> </tbody> </table>			Category	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³	A	DE, A, 2200356 (ROBERT BOSCH GMBH) 12 July 1973, see the whole document --		A	DE, B, 1021732 (MASCHINENFABRIK AUGSBURG-NURNBERG A.G.) 27 December 1957, see the whole document --	A	WO, A1, 8912766 (THE UNIVERSITY OF LANCASTER) 28 December 1989, see the whole document --	A	Derwent's abstract, No. 89-240 255/33, SU 1 458 629, publ. week 8933 (COACH BUILDING RES) --
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<div style="display: flex; justify-content: space-between;"> <div style="width: 48%;"> <p>[*] Special categories of cited documents:¹⁰</p> <p>^{"A"} document defining the general state of the art which is not considered to be of particular relevance</p> <p>^{"E"} earlier document but published on or after the international filing date</p> <p>^{"L"} document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>^{"O"} document referring to an oral disclosure, use, exhibition or other means</p> <p>^{"P"} document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 48%;"> <p>^{"T"} later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>^{"X"} document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>^{"Y"} document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>^{"&"} document member of the same patent family</p> </div> </div>														
IV. CERTIFICATION <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; border-bottom: 1px solid black; padding: 2px;">Date of the Actual Completion of the International Search</td> <td style="width: 50%; border-bottom: 1px solid black; padding: 2px;">Date of Mailing of this International Search Report</td> </tr> <tr> <td style="padding: 5px;">18th December 1990</td> <td style="padding: 5px; text-align: center;">1990-12-21</td> </tr> <tr> <td style="border-bottom: 1px solid black; padding: 2px;">International Searching Authority</td> <td style="border-bottom: 1px solid black; padding: 2px;">Signature of Authorized Officer</td> </tr> <tr> <td style="padding: 5px; text-align: center;">SWEDISH PATENT OFFICE</td> <td style="padding: 5px; text-align: center;">Marianne Dickman</td> </tr> </table>			Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	18th December 1990	1990-12-21	International Searching Authority	Signature of Authorized Officer	SWEDISH PATENT OFFICE	Marianne Dickman				
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SWEDISH PATENT OFFICE	Marianne Dickman													

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III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
A	US, A, 3375002 (P.L. BREON ET AL) 26 March 1968, see the whole document --	
A	US, A, 2981354 (A.E. ROLLER) 25 April 1961, see the whole document -- -----	

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ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. PCT/SE 90/00628

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the Swedish Patent Office EDP file on **90-11-28**.
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE-A- 2200356	73-07-12	NONE	
DE-B- 1021732	57-12-27	NONE	
WO-A1- 8912766	89-12-28	AU-D- 3967489	90-01-12
US-A- 3375002	68-03-26	NONE	
US-A- 2981354	61-04-25	NONE	